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CONVERSION TABLES AND EQUIVALENTS FOR USE IN WORK RELATING TO INSECT CONTROL

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Contents

INTRODUCTION

In the literature on economic entomology the weights and measures used in expressing insecticide dilutions, dosages, and the like may be in one or more of three systems--the United States, the imperial (British), and the metric. Since information on the relationships and equivalents in these systems is not always readily available to entomologists in the field, it has been assembled here for their benefit. The data are taken principally from publications of the National Bureau of Standards (2, 3) and the International Critical Tables (4). A comparative discussion of United States and British units, by Bearce (1), of the National Bureau of Standards, was also consulted.

Tables for dilutions of insecticides, methods of calculating dilutions on the basis of active ingredients, and certain other miscellaneous information useful to entomologists working with insecticides have also been included.

In the tables of equivalents the values shown are correct to the decimal place given, but in most cases are not to be taken as exact. They are, however, carried out far enough so that the individual worker may round out at the decimal place best suited for his equipment and the conditions of his experiment with a minimum of error.

The abbreviations used are those recognized in the January 1939 edition of the United States Government Printing Office Style Manual (6).

WEIGHT TABLES

United States Avoirdupois Weight

27 11/32	grains (gr.)	= 1 dram (dr.)
16	drams	= 1 ounce (oz.)
16	ounces	= 1 pound (lb.) = 7,000 grains
100	pounds	= 1 hundredweight (cwt.)
2,000	pounds	= 1 short ton
2,240	pounds	= 1 long ton

Metric Weight

1,000	micrograms	= 1 milligram (mg.)
1,000	milligrams	= 1 gram (gm.)
1,000	grams	= 1 kilogram (kg.)
1,000	kilograms	= 1 metric ton

Apothecaries' Weight

20	grains (gr.)	= 1 scruple (s.)
3	scruples	= 1 dram (dr.)
8	drams	= 1 ounce (oz.)
12	ounces	= 1 pound (lb.) = 5,760 grains

Although not commonly used in entomological work, the system of apothecaries' weight is included for purposes of comparison. In all other parts of this paper the terms "dram," "ounce," and "pound" refer to avoirdupois weight unless otherwise specified.

Imperial (British) Avoirdupois Weight

27 11/32	grains	= 1 dram
16	drams	= 1 ounce
16	ounces	= 1 pound = 7,000 grains
14	pounds	= 1 stone
8	stone)	
112	pounds)	= 1 hundredweight
20	hundredweight)	
2,240	pounds	)= 1 ton

The imperial avoirdupois units, although differing in definition, are for practical purposes equal to the United States units of the same name. The same conversion values may be used with either. This table is included to show certain variations in terminology between this system and that commonly used in the United States.

Equivalents of Weight of the Four Systems

Avoirdupois, United States and imperial	Metric	Apothecaries'
1 grain	64.7989 milligrams	1 grain
1 dram	1,771.85 milligrams 1.77185 grams	0.4557 dram
1 ounce	28.3495 grams	0.9115 ounce
1 pound	453.59 grams 0.45359 kilogram	1.21528 pounds
0.015432 grain	1 milligram	0.015432 grain
15.432 grains 0.56438 dram 0.03527 ounce	1 gram	15.432 grains 0.2572 dram 0.03215 ounce
35.2740 ounces 2.2046 pounds	1 kilogram	32.1507 ounces 2.6792 pounds
0.7314 dram	1,295.98 milligrams 1.29598 grams	1 scruple
2.19429 drams	3.8879 grams	1 dram
1.0971 ounces	31.10348 grams	1 ounce
0.8229 pound	373.24 grams 0.37324 kilogram	1 pound

CAPACITY TABLES (LIQUID)

United States Liquid Measure

8 fluid drams (fl. dr.)	= 1 fluid ounce (fl. oz.)
4 fluid ounces	= 1 gill
4 gills	= 1 pint (pt.)
2 pints	= 1 quart (qt.)
4 quarts	= 1 gallon (gal.) = 231 cubic inches

At maximum density, 39.164° F. (3.98° C.), a gallon of pure water weighs 8.345 pounds; at 59° F. (15° C.) the weight is 8.338 pounds.

Metric Capacity Measure

1,000 milliliters (ml.)1/	= 1 liter (l.) = 1,000.027 cubic centimeters
10 liters	= 1 dekaliter (dkl.)
100 liters	= 1 hectoliter (hl.)
1,000 liters	= 1 kiloliter (kl.)

Imperial Capacity Measure

8 fluid drams	= 1 fluid ounce
5 fluid ounces	= 1 gill
4 gills	= 1 pint
2 pints	= 1 quart
4 quarts	= 1 gallon = 277.42 cubic inches

An imperial gallon of pure water weighs 10 pounds at 62° F. (16.67° C.)

The units of the imperial system for liquid measure have the same names as those used in the United States system. In no case, however, are they equal. The imperial gallon, quart, and pint are about 20 percent larger than the United States units of the same name, whereas the imperial fluid dram and fluid ounce are about 4 percent smaller than homonymous United States units.

1/ The term "cubic centimeter (cc. or $cm.^3$)" has been commonly used in chemical and entomological literature instead of "milliliter (ml.)." Technically this is not correct, since the cubic centimeter is a measure of volume, not of capacity. Their relationship is: 1 milliliter = 1.000027 cubic centimeters. For practical purposes, however, they may be regarded as equal in the same sense as 1 gallon equals 231 cubic inches.

Equivalents of Capacity in the Three Systems

United States		Metric		Imperial	
1 fluid dram		3.6966	milliliters	1.0408	fluid drams
1 fluid ounce		29.5729	milliliters	1.0408	fluid ounces
1 gill		118.292	milliliters	0.83268	gill
		0.118292	liter		
1 pint		473.167	milliliters	0.83268	pint
		0.473167	liter		
1 quart		946.33	milliliters	0.83268	quart
		0.94633	liter		
1 gallon		3,785.33	milliliters	0.83268	gallon
		3.78533	liters		
0.270518	fluid dram	1 milliliter		0.28157	fluid dram
270.518	fluid drams)			(281.57	fluid drams
33.8147	fluid ounces)	1 liter		(35.20	fluid ounces
1.0567	quarts)			(0.880	quart
0.264178	gallon)			(0.2200	gallon
2.64178	gallons	1 dekaliter		2.200	gallons
26.4178	gallons	1 hectoliter		22.00	gallons
264.178	gallons	1 kiloliter		219.98	gallons
0.96075	fluid dram	3.5515	milliliters	1 fluid dram	
0.96075	fluid ounce	28.412	milliliters	1 fluid ounce	
1.20094	gills	142.06	milliliters	1 gill	
		0.14206	liter		
1.20094	pints	568.245	milliliters	1 pint	
		0.568245	liter		
1.20094	quarts	1,136.49	milliliters	1 quart	
		1.13649	liters		
1.20094	gallons	4,545.96	milliliters	1 gallon	
		4.54596	liters		

Equivalents for Teaspoonful, Tablespoonful, and Cup

A measuring cup and measuring spoons, the latter obtainable in nests of several sizes, are useful in making dilutions under practical conditions where great accuracy is not required. The values given below are also useful in transposing the precise measurements of the laboratory into commonly used and understood units when an insecticide is recommended to dooryard gardeners. The values as given are those recognized by the Bureau of Standards.

3 teaspoonfuls = 1 tablespoonful
2 tablespoonfuls = 1 fluid ounce
16 tablespoonfuls) = 1 cup
8 fluid ounces)

3 teaspoonfuls)
½ fluid ounce) = 1 tablespoonful
4 fluid drams)
15 milliliters)

16 tablespoonfuls)
2 gills)
½ pint) = 1 cup
8 fluid ounces)
237 milliliters)

1 pint)
16 fluid ounces) = 2 cups
473 milliliters)

CAPACITY TABLES (DRY)

United States Dry Measure

2 pints (pt.) = 1 quart (qt.)
8 quarts = 1 peck (pk.)
4 pecks = 1 bushel (bu.) = 2,150.42 cubic inches

In the United States system the pint and quart of dry measure are about 16 percent larger than the units of the same name used in liquid measure. Wherever these unit names are used in this paper, other than in this section, they refer to liquid measure.

Metric Capacity Measure

In the metric system both dry and liquid capacity are measured by the liter and its secondary units. See Capacity Tables (Liquid), p 5.

Imperial Capacity Measure

2 pints = 1 quart
8 quarts = 1 peck
4 pecks = 1 bushel = 2,219.34 cubic inches

The pint and quart of the imperial system are the same for both liquid and dry measure. The imperial gallon may also be used as a unit of dry measure. The pint and quart of the United States dry measure are approximately 3 percent smaller than the imperial units of the same name. The United States bushel is the same as the Winchester bushel, sometimes mentioned in publications from the British Empire.

Equivalents of Capacity in the Three Systems

United States	Metric	Imperial
1 pint	550.60 milliliter 0.55060 liter	0.96895 pint
1 quart	1.10120 liters	0.96895 quart
1 peck	8.810 liters 0.8810 dekaliter	0.96895 peck
1 bushel	35.238 liters 3.5238 dekaliters 0.35238 hectoliters	0.96895 bushel
1.816 pints 0.908 quart 0.1135 peck	1 liter	1.760 pints 0.880 quart 0.110 peck
1.135 pecks 0.28378 bushel	1 dekaliter	1.10 pecks 0.275 bushel
2.8378 bushels	1 hectoliter	2.75 bushels
1.03205 pints	568.245 milliliters 0.568245 liter	1 pint
1.03205 quarts	1.13649 liters	1 quart
1.03205 pecks	9.092 liters 0.9092 dekaliter	1 peck
1.03205 bushels	36.368 liters 3.6368 dekaliters 0.36368 hectoliter	1 bushel

LINEAR-MEASURE TABLES

United States System

12	inches (in.)	= 1 foot (ft.)
3	feet	= 1 yard (yd.)
5½	yards)	= 1 rod (rd.)
16½	feet)	
320	rods)	
1,760	yards)	= 1 mile
5,280	feet)	

Metric System

1,000 millimicrons [1]	= 1 micron [2]
1,000 microns	= 1 millimeter (mm.)
10 millimeters	= 1 centimeter (cm.)
10 centimeters	= 1 decimeter (dm.)
10 decimeters	= 1 meter (m.)
10 meters	= 1 dekameter (dkm.)
10 dekameters	= 1 hectometer (hm.)
10 hectometers	= 1 kilometer (km.)

Imperial System

Except for small differences in standards, this system is the same as that used in the United States and the same conversion values may be used.

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[1] Abbreviation is "m" followed by the Greek letter "mu."

[2] Abbreviation is the Greek letter "mu."

Equivalents of Length is the Three Systems

United States and Imperial		Metric	
		25.4	millimeters
1 inch		2.54	centimeters
		30.48	centimeters
1 foot		3.048	decimeters
		9.144	decimeters
1 yard		0.9144	meter
		5.029	meters
1 rod		0.5029	dekameter
		1,609.35	meters
1 mile		1.60935	kilometers
0.03937	inch	1 millimeter	
0.3937	inch	1 centimeter	
3.937	inches		
0.328	foot	1 decimeter	
39.37	inches		
1.0936	yards	1 meter	
1.98838	rods	1 dekameter	
19.8838	rods	1 hectometer	
198.838	rods		
0.62137	mile	1 kilometer	

AREA-MEASUREMENT TABLES

United States System

144	square inches (sq. in.)	= 1 square foot (sq. ft.)
9	square feet	= 1 square yard (sq. yd.)
30¼	square yards	= 1 square rod (sq. rd.)
43,560	square feet	
4,840	square yards	= 1 acre
160	square rods	

Metric System

100 square millimeters (mm.²)	= 1 square centimeter (cm.²)
100 square centimeters	= 1 square decimeter (dm.²)
100 square decimeters	= 1 square meter (m.²)
100 square meters	= 1 are (a.)
100 ares	= 1 hectare (ha.)

Imperial System

Except for slight differences in standards this is the same as the United States system for area measurement, and the two are combined in the following table:

Equivalents of Area in the Three Systems

United States and Imperial		Metric	
1 square inch		6.452	square centimeters
1 square foot		9.2903	square decimeters
1 square yard		0.8361	square meter
1 square rod		25.29 0.2529	square meters are
1 acre		0.40469	hectare
0.00155	square inch	1 square millimeter	
0.155	square inch	1 square centimeter	
15.5 0.1076	square inches square foot	1 square decimeter	
1.1960	square yards	1 square meter	
3.9537	square rods	1 are	
2.471	acres	1 hectare	

VOLUME (CUBIC MEASURE) TABLES

United States System

1,728 cubic inches (cu. in.) = 1 cubic foot (cu. ft.)
27 cubic feet = 1 cubic yard (cu. yd.)

Metric System

1,000 cubic millimeters ($mm.^3$) = 1 cubic centimeter (cc. or cm^3)
1,000 cubic centimeters = 1 cubic decimeter ($dm.^3$)
1,000 cubic decimeters = 1 cubic meter ($m.^3$)

Imperial System

This is the same as the United States system except for small differences in standards, and the two are combined in the following table:

Equivalents of Volume in the Three Systems

United States and Imperial	Metric
1 cubic inch	16.39 cubic centimeters
1 cubic foot	28.317 cubic decimeters
1 cubic yard	0.7646 cubic meter
0.061 cubic inch	1 cubic centimeter
61.023 cubic inches 0.0353 cubic foot	1 cubic decimeter
1.308 cubic yards	1 cubic meter

DILUTIONS OF INSECTICIDES

Equivalent Quantities of Insecticidal Material for Various Quantities of Water

Dry material.--The quantity of powdered insecticide recommended for use against a given insect is usually stated in pounds per 50 or 100 gallons of water. Tables 1 and 2 show the quantities necessary for making the same dilutions in smaller quantities of water as are made with 1 to 10 pounds, inclusive, in 100 gallons. It will be noted in table 1 that the number of pounds per 100 gallons is the same as the number of ounces per $6\frac{1}{4}$ gallons, and that the same is true for 50 and $3\frac{1}{8}$ gallons. For $2\frac{1}{2}$ gallons, which is a convenient amount of spray solution for use in most knapsack sprayers, the quantities are given in both ounces and grams to one decimal place.

In table 2, for quantities of water of 1 gallon or more, the nearest correct value at one decimal place is given. For values of less than 1 pound the equivalent quantities are given in grams directly beneath the United States values. The gram being of smaller mass than the dram and the ounce, the metric values are, in most cases, more nearly correct than the avoirdupois values. The quantities to be used in 1 quart and 1 liter of water are given only in metric units and are carried out to three places, since they will presumably be used for small-scale, precise experiments.

Table 1.--Equivalent quantities of dry insecticidal material for certain aliquots of 100 gallons of water

Quantity of material in indicated quantity of water						
100 gal.	50 gal.	25 gal.	12½ gal.	6¼ gal.	3⅛ gal.	2½ gal.
1 lb.	½ lb.	4 oz.	2 oz.	1 oz.	½ oz.	0.4 oz. 11.3 gm.
2 lb.	1 lb.	8 oz.	4 oz.	2 oz.	1 oz.	0.8 oz. 22.7 gm.
3 lb.	1½ lb.	12 oz.	6 oz.	3 oz.	1½ oz.	1.2 oz. 34.0 gm.
4 lb.	2 lb.	1 lb.	8 oz.	4 oz.	2 oz.	1.6 oz. 45.4 gm.
5 lb.	2½ lb.	1¼ lb.	10 oz.	5 oz.	2½ oz.	2.0 oz. 56.7 gm.
6 lb.	3 lb.	1½ lb.	12 oz.	6 oz.	3 oz.	2.4 oz. 68.0 gm.
7 lb.	3½ lb.	1¾ lb.	14 oz.	7 oz.	3½ oz.	2.8 oz. 79.4 gm.
8 lb.	4 lb.	2 lb.	1 lb.	8 oz.	4 oz.	3.2 oz. 90.7 gm.
9 lb.	4½ lb.	2¼ lb.	1⅛ lb.	9 oz.	4½ oz.	3.6 oz. 102.1 gm.
10 lb.	5 lb.	2½ lb.	1¼ lb.	10 oz.	5 oz.	4.0 oz. 113.4 gm.

Table 2.—Equivalent quantities of dry insecticidal material for various quantities of water.

Quantity of material for indicated quantity of water												
100 gal.	50 gal.	40 gal.	30 gal.	20 gal.	10 gal.	5 gal.	4 gal.	3 gal.	2 gal.	1 gal.	1 quart	1 liter
1 lb.	½ lb.	6.4 oz. 181.4 gm.	4.8 oz. 136.1 gm.	3.2 oz. 90.7 gm.	1.6 oz. 45.4 gm.	12.8 dr. 22.7 gm.	10.2 dr. 18.1 gm.	7.7 dr. 13.6 gm.	5.1 dr. 9.1 gm.	2.6 dr. 4.5 gm.	1.134 gm.	1.198 gm.
2 lb.	1 lb.	12.8 oz. 362.9 gm.	9.6 oz. 272.2 gm.	6.4 oz. 181.4 gm.	3.2 oz. 90.7 gm.	1.6 oz. 45.4 gm.	1.3 oz. 36.3 gm.	15.4 dr. 27.2 gm.	10.2 dr. 18.1 gm.	5.1 dr. 9.1 gm.	2.268 gm.	2.397 gm.
3 lb.	1½ lb.	1 lb. 3.2oz.	14.4 oz. 408.2 gm.	9.6 oz. 272.2 gm.	4.8 oz. 136.1 gm.	2.4 oz. 68.0 gm.	1.9 oz. 54.4 gm.	1.4 oz. 40.8 gm.	15.4 dr. 27.2 gm.	7.7 dr. 13.6 gm.	3.402 gm.	3.595 gm.
4 lb.	2 lb.	1 lb.9.6 oz.	1 lb.3.2oz.	12.8 oz. 362.9 gm.	6.4 oz. 181.4 gm.	3.2 oz. 90.7 gm.	2.6 oz. 72.6 gm.	1.9 oz. 54.4 gm.	1.3 oz. 36.3 gm.	10.2 dr. 18.1 gm.	4.536 gm.	4.793 gm.
5 lb.	2½ lb.	2 lb.	1 lb.8 oz.	1 lb.	8 oz. 226.8 gm.	4 oz. 113.4 gm.	3.2 oz. 90.7 gm.	2.4 oz. 68.0 gm.	1.6 oz. 45.4 gm.	12.8 dr. 22.7 gm.	5.670 gm.	5.991 gm.
6 lb.	3 lb.	2 lb.6.4oz.	1 lb.12.8oz.	1 lb.3.2oz.	9.6 oz. 272.2 gm.	4.8 oz. 136.1 gm.	3.8 oz. 108.9 gm.	2.9 oz. 81.6 gm.	1.9 oz. 54.4 gm.	15.4 dr. 27.2 gm.	6.804 gm.	7.190 gm.
7 lb.	3½ lb.	2 lb.12.8oz.	2 lb. 1.6oz.	1 lb.6.4oz.	11.2 oz. 317.5 gm.	5.6 oz. 158.8 gm.	4.5 oz. 127.0 gm.	3.4 oz. 95.3 gm.	2.2 oz. 63.5 gm.	1.1 oz. 31.8 gm.	7.938 gm.	8.388 gm.
8 lb.	4 lb.	3 lb.3.2oz.	2 lb. 6.4oz.	1 lb.9.6oz.	12.8 oz. 362.9 gm.	6.4 oz. 181.4 gm.	5.1 oz. 145.1 gm.	3.8 oz. 108.9 gm.	2.6 oz. 72.6 gm.	1.3 oz. 36.3 gm.	9.072 gm.	9.586 gm.
9 lb.	4½ lb.	3 lb.9.6oz.	2 lb.11.2oz.	1 lb.12.8oz.	14.4 oz. 408.2 gm.	7.2 oz. 204.1 gm.	5.8 oz. 163.3 gm.	4.3 oz. 122.5 gm.	2.9 oz. 81.6 gm.	1.4 oz. 40.8 gm.	10.206 gm.	10.785gm.
10 lb.	5 lb.	4 lb.	3 lb.	2 lb.	1 lb.	8 oz. 226.8 gm.	6.4 oz. 181.4 gm.	4.8 oz. 136.1 gm.	3.2 oz. 90.7 gm.	1.6 oz. 45.4 gm.	11.340 gm.	11.983gm.

Liquid material.--Tables 3 and 4 have been worked out in a manner similar to tables 1 and 2 but are in fluid measure for use with liquid insecticides, wetting agents, and the like. The relationship of pounds and ounces noted for table 1 holds for pints and fluid ounces in table 3. Quantities for 2½ gallons are given in both United States and metric units to one decimal place.

In table 4 an equivalent value in fluid ounces is given for the fractional pint values. For quantities of less than 1 pint equivalent quantities in milliliters are given for the fluid-ounce and fluid-dram values.

Table 3.--Equivalent quantities of liquid insecticidal material for certain aliquots of 100 gallons of water

Quantities of material for indicated quantities of water						
100 gal.	50 gal.	25 gal.	12½ gal.	6¼ gal.	3⅛ gal.	2½ gal.
½ pt.	¼ pt. 4 fl.oz.	2 fl.oz.	1 fl.oz.	½ fl.oz.	¼ fl.oz.	0.2 fl.oz. 5.9 ml.
1 pt.	½ pt. 8 fl.oz.	4 fl.oz.	2 fl.oz.	1 fl.oz.	½ fl.oz.	0.4 fl.oz. 11.8 ml.
2 pt. 1 qt.	1 pt.	8 fl.oz.	4 fl.oz.	2 fl.oz.	1 fl.oz.	0.8 fl.oz. 23.7 ml.
3 pt. 1½ qt.	1½ pt.	12 fl.oz.	6 fl.oz.	3 fl.oz.	1½ fl.oz.	1.2 fl.oz. 35.5.ml.
4 pt. 2 qt.	2 pt. 1 qt.	1 pt.	8 fl.oz.	4 fl.oz.	2½ fl.oz.	1.6 fl.oz. 47.3 ml.
5 pt. 2½ qt.	2½ pt. 1¼ qt.	1¼ pt.	10 fl.oz.	5 fl.oz.	2½ fl.oz.	2.0 fl.oz. 59.1 ml.
6 pt. 3 qt.	3 pt. 1½ qt.	1½ pt.	12 fl.oz.	6 fl.oz.	3 fl.oz.	2.4 fl.oz. 71.0 ml.
7 pt. 3½ qt.	3½ pt. 1¾ qt.	1¾ pt.	14 fl.oz.	7 fl.oz.	3½ fl.oz.	2.8 fl.oz. 82.8 ml.
8 pt. 1 gal.	4 pt. 2 qt.	2 pt. 1 qt.	1 pt.	8 fl.oz.	4 fl.oz.	3.2 fl.oz. 94.6 ml.

Table 4.—Equivalent quantities of liquid insecticidal material for various quantities of water.

Quantities of material for indicated quantities of water												
100 gal.	50 gal.	40 gal.	30 gal.	20 gal.	10 gal.	5 gal.	4 gal.	3 gal.	2 gal.	1 gal.	1 quart	1 liter
½ pt.	¼ pt. 4 fl.oz.	3.2 fl.oz. 94.6 ml.	2.4 fl.oz. 71.0 ml.	1.6 fl.oz. 47.3 ml.	6.4 fl.dr. 23.7 ml.	3.2 fl.dr. 11.8 ml.	2.6 fl.dr. 9.5 ml.	1.9 fl.dr. 7.1 ml.	1.3 fl.dr. 4.7 ml.	2.4 ml.	0.591 ml.	0.625 ml
1 pt.	½ pt. 8 fl.oz.	6.4 fl.oz. 189.3 ml.	4.8 fl.oz. 141.9 ml.	3.2 fl.oz. 94.6 ml.	1.6 fl.oz. 47.3 ml.	6.4 fl.dr. 23.7 ml.	5.1 fl.dr. 18.9 ml.	3.8 fl.dr. 14.2 ml.	2.6 fl.dr. 9.5 ml.	1.3 fl.dr 4.7 ml.	1.183ml.	1.250ml.
1 qt.	1 pt.	12.8fl.oz. 378.5 ml.	9.6 fl.oz. 283.9 ml.	6.4 fl.oz. 189.3 ml.	3.2 fl.oz. 94.6 ml.	1.6 fl.oz. 47.3 ml.	1.3 fl.oz. 37.9 ml.	7.7 fl.dr. 28.4 ml.	5.1 fl.dr. 18.9 ml.	2.6fl.dr. 9.5 ml.	2.366ml.	2.500ml.
1½ qt.	1½ pt.	1.2 pt. 19.2 fl.	14.4fl.oz. 425.8 ml.	9.6 fl.oz. 283.9 ml.	4.8 fl.oz. 141.9 ml.	2.4 fl.oz. 71.0 ml.	1.9 fl.oz. 56.8 ml.	1.4 fl.oz. 42.6 ml.	7.7 fl.dr. 28.4 ml.	3.8fl.dr. 14.2 ml.	3.549ml	3.750ml.
2 qt.	2 pt. 1 qt.	1.6 pt. 25.6fl.oz.	1.2 pt. 19.2fl.oz.	12.8fl.oz. 378.5 ml.	6.4 fl.oz. 189.3 ml.	3.2 fl.oz. 94.6 ml.	2.6 fl.oz. 75.7 ml.	1.9 fl.oz. 56.8 ml.	1.3 fl.oz. 37.9 ml.	5.1fl.dr. 18.9 ml.	4.732ml.	5.000ml.
2½ qt.	2½ pt. 1¼ qt.	2 pt.	1½ pt.	1 pt.	½ pt. 8 fl.oz.	4 fl.oz. 118.3 ml.	3.2 fl.oz. 94.6 ml.	2.4 fl.oz. 71.0 ml.	1.6 fl.oz. 47.3 ml	6.4fl.dr. 23.7 ml.	5.915ml.	6.250ml.
3 qt.	3 pt. 1½ qt.	2.4 pt. 38.4fl.oz.	1.8 pt. 28.8fl.oz.	1.2 pt. 19.2fl.oz.	9.6 fl.oz. 283.9 ml.	4.8fl.oz. 141.9 ml.	3.8 fl.oz. 113.6 ml.	2.9fl.oz. 85.2 ml.	1.9 fl.oz. 56.8 ml.	7.7fl.dr. 28.4 ml.	7.097ml.	7.500ml.
3½ qt.	3½ pt. 1¾ qt.	2.8 pt. 44.8fl.oz.	2.1 pt. 33.6fl.oz.	1.4 pt. 22.4fl.oz.	11.2fl.oz. 331.2 ml.	5.6fl.oz. 165.6 ml.	4.5 fl.oz. 132.5 ml.	3.4 fl.oz. 99.4 ml.	2.2fl.oz. 66.2 ml.	1.1fl.oz. 33.1 ml.	8.280 ml	8.750ml.
1 gal.	4 pt. 2 qt.	3.2 pt. 51.2fl.oz.	2.4 pt. 38.4fl.oz.	1.6 pt. 25.6fl.oz.	12.8fl.oz. 378.5 ml.	6.4fl.oz. 189.3 ml.	5.1fl.oz. 151.4 ml.	3.8fl.oz. 113.6 ml.	2.6fl.oz. 75.7 ml.	1.3fl.oz. 37.9 ml.	9.463ml.	10.000ml.

Dilution of Insecticides in Parts by Weight and by Liquid Measure

The quantities of dry insecticidal material giving certain dilutions by weight in various quantities of water are given in table 5. In calculating these quantities the weight of 1 gallon of water was considered as 8.345 pounds, or 3,785.3 grams. Quantities of less than 1 pound are given in both ounces and grams.

Table 6 contains similar data worked out in liquid measure for certain dilutions of liquid insecticides.

In both tables the quantities to be used in 1 gallon or more are calculated to the nearest correct value at one decimal place. For 1 quart and 1 liter these values are carried out to three places.

Table 5.—Quantities of dry insecticidal materials giving certain dilutions in parts by weight in various quantities of water.

Dilution	Weight of insecticide in indicated quantity of water									
	100 gal.	50 gal.	25 gal.	15 gal.	10 gal.	5 gal.	3 gal.	2 gal.	1 gal.	1 quart	1 liter
1-50	16 lb. 11.0 oz.	8 lb. 5.5 oz.	4 lb. 2.8 oz.	2 lb. 8.0 oz.	1 lb. 10.7 oz.	13.4 oz. 378.5 gm.	8.0 oz. 227.1 gm.	5.3 oz. 151.4 gm.	2.7 oz. 75.7 gm.	18.926 gm.	20.000gm.
1-100	8 lb. 5.5 oz.	4 lb. 2.8 oz.	2 lb. 1.4 oz.	1 lb. 4.0 oz.	13.4 oz. 378.5 gm.	6.7 oz. 189.3 gm.	4.0 oz. 113.6 gm.	2.7 oz. 75.7 gm.	1.3 oz. 37.9 gm.	9.463 gm.	10.000gm.
1-200	4 lb. 2.8 oz.	2 lb. 1.4 oz.	1 lb. 0.7 oz.	10.0 oz. 283.9 gm.	6.7 oz. 189.3 gm.	3.3 oz. 94.6 gm.	2.0 oz. 56.8 gm.	1.3 oz. 37.9 gm.	10.7 dr. 18.9 gm.	4.732 gm.	5.000gm.
1-300	2 lb. 12.5 oz.	1 lb. 6.3 oz.	11.1 oz. 315.4 gm.	6.7 oz. 189.3 gm.	4.5 oz. 126.2 gm.	2.2 oz. 63.1 gm.	1.3 oz. 37.9 gm.	14.2 dr. 25.2 gm.	7.1 dr. 12.6 gm.	3.154 gm.	3.333gm.
1-400	2 lb. 1.4 oz.	1 lb. 0.7 oz.	8.3 oz. 236.6 gm.	5.0 oz. 141.9 gm.	3.3 oz. 94.6 gm.	1.7 oz. 47.3 gm.	1.0 oz. 28.4 gm.	10.7 dr. 18.9 gm.	5.3 dr. 9.5 gm.	2.366 gm.	2.500gm.
1-500	1 lb. 10.7 oz.	13.4 oz. 378.5 gm.	6.7 oz. 189.3 gm.	4.0 oz. 113.6 gm.	2.7 oz. 75.7 gm.	1.3 oz. 37.9 gm.	12.8 dr. 22.7 gm.	8.5 dr. 15.1 gm.	4.3 dr. 7.6 gm.	1.893 gm.	2.000gm.
1-600	1 lb. 6.3 oz.	11.1 oz. 315.4 gm.	5.6 oz 157.7 gm.	3.3 oz. 94.6 gm.	2.2 oz. 63.1 gm.	1.1 oz. 31.5 gm.	10.7 dr. 18.9 gm.	7.1 dr. 12.6 gm.	3.6 dr. 6.3 gm.	1.577 gm.	1.667gm.
1-800	1 lb. 0.7 oz.	8.3 oz. 236.6 gm.	4.2 oz. 118.3 gm.	2.5 oz. 71.0 gm.	1.7 oz. 47.3 gm.	13.4 dr. 23.7 gm.	8.0 dr. 14.2 gm.	5.3 dr. 9.5 gm.	2.7 dr. 4.7 gm.	1.183 gm.	1.250gm.
1-1,000	13.4 oz. 378.5 gm.	6.7 oz. 189.3 gm.	3.3 oz. 94.6 gm.	2.0 oz. 56.8 gm.	1.3 oz. 37.9 gm.	10.7 dr. 18.9 gm.	6.4 dr. 11.4 gm.	4.3 dr. 7.6 gm.	2.1 dr. 3.8 gm.	0.946 gm.	1.000gm.
1-1,200	11.1 oz. 315.4 gm.	5.6 oz. 157.7 gm.	2.8 oz. 78.9 gm.	1.7 oz. 47.3 gm.	1.1 oz. 31.5 gm.	8.9 dr. 15.8 gm.	5.3 dr. 9.5 gm.	3.6 dr. 6.3 gm.	1.8 dr. 3.2 gm.	0.789 gm.	0.833gm.
1-1,600	8.3 oz. 236.6 gm.	4.2 oz. 118.3 gm.	2.1 oz. 59.1 gm.	1.3 oz. 35.5 gm.	13.4 dr. 23.7 gm.	6.7 dr. 11.8 gm.	4.0 dr. 7.1 gm.	2.7 dr. 4.7 gm.	1.3 dr. 2.4 gm.	0.591 gm.	0.625 gm.
1-2,000	6.7 oz. 189.3 gm.	3.3 oz. 94.6 gm.	1.7 oz. 47.3 gm.	1.0 oz. 28.4 gm.	10.7 dr. 18.9 gm.	5.3 dr. 9.5 gm.	3.2 dr. 5.7 gm.	2.1 dr. 3.8 gm.	1.1 dr. 1.9 gm.	0.473 gm.	0.500gm.

Table 6.—Quantities of insecticidal materials giving certain dilutions in parts by liquid measure in various quantities of water.

Dilution	Quantity of insecticide in indicated quantity of water										
	100 gal.	50 gal.	25 gal.	15 gal.	10 gal.	5 gal.	3 gal.	2 gal.	1 gal.	1 quart	1 liter
1-50	8 qt. 2 gal.	4 qt. 1 gal.	2 qt.	1.2 qt. 38.4 fl.oz.	1.6 pt. 25.6 fl.oz.	12.8 fl.oz. 378.5 ml.	7.7 fl.oz. 227.1 ml.	5.1 fl.oz. 151.4 ml.	2.6 fl.oz. 75.7 ml.	18.926 ml.	20.000 ml.
1-100	4 qt. 1 gal.	2 qt.	1 qt.	1.2 pt. 19.2 fl.oz.	.8 pt. 12.8 fl.oz.	6.4 fl.oz. 189.3 ml.	3.8 fl.oz. 113.6 ml.	2.6 fl.oz. 75.7 ml.	1.3 fl.oz. 37.9 ml.	9.463 ml.	10.000 ml.
1-200	2 qt.	1 qt.	1 pt.	.6 pt. 9.6 fl.oz.	.4 pt. 6.4 fl.oz.	3.2 fl.oz. 94.6 ml.	1.9 fl.oz. 56.8 ml.	1.3 fl. oz. 37.9 ml.	5.1 fl.dr. 18.9 ml.	4.732 ml.	5.000 ml.
1-300	1 1/3 qt.	2/3 qt. 1 1/3 pt.	2/3 pt. 10.7 fl.oz.	.4 pt. 6.4 fl.oz.	4.3 fl.oz. 126.2 ml.	2.1 fl.oz. 63.1 ml.	1.3 fl.oz. 37.8 ml.	6.8 fl.dr. 25.2 ml.	3.4 fl.dr. 12.6 ml.	3.154 ml.	3.333 ml.
1-400	1 qt.	1 pt.	½ pt. 8 fl.oz.	4.8 fl.oz. 141.9 ml.	3.2 fl.oz. 94.6 ml.	1.6 fl.oz. 47.3 ml.	7.7 fl.dr. 28.4 ml.	5.1 fl.dr. 18.9 ml.	2.6 fl.dr. 9.5 ml.	2.366 ml.	2.500 ml.
1-500	1.6 pt.	.8 pt. 12.8 fl.oz.	.4 pt. 6.4 fl.oz.	3.8 fl.oz. 113.6 ml.	2.6 fl.oz. 75.7 ml.	1.3 fl.oz. 37.9 ml.	6.1 fl.dr. 22.7 ml.	4.1 fl.dr. 15.1 ml.	2.0 fl.dr. 7.6 ml.	1.893 ml.	2.000 ml.
1-600	2/3 qt. 1 1/3 pt.	2/3 pt. 10.7 fl.oz.	1/3 pt. 5.3 fl.oz.	3.2 fl.oz. 94.6 ml.	2.1 fl.oz. 63.1 ml.	1.1 fl.oz. 31.5 ml.	5.1 fl.dr. 18.9 ml.	3.4 fl.dr. 12.6 ml.	1.7 fl.dr. 6.3 ml.	1.577 ml.	1.667 ml.
1-800	1 pt.	½ pt. 8 fl.oz.	¼ pt. 4 fl.oz.	2.4 fl.oz. 71.0 ml.	1.6 fl.oz. 47.3 ml.	6.4 fl.dr. 23.7 ml.	3.8 fl.dr. 14.2 ml.	2.6 fl.dr. 9.5 ml.	1.3 fl.dr. 4.7 ml.	1.183 ml.	1.250 ml.
1-1,000	.8 pt. 12.8 fl.oz.	.4 pt. 6.4 fl.oz.	3.2 fl.oz. 94.6 ml.	1.9 fl.oz. 56.8 ml.	1.3 fl.oz. 37.9 ml.	5.1 fl.dr. 18.9 ml.	3.1 fl.dr. 11.4 ml.	2.0 fl.dr. 7.6 ml.	1 fl.dr. 3.8 ml.	0.946 ml.	1.000 ml.
1-1,200	2/3 pt. 10.7 fl.oz.	1/3 pt. 5.3 fl.oz.	2.7 fl.oz. 78.9 ml.	1.6 fl.oz. 47.3 ml.	1.1 fl.oz. 31.5 ml.	4.3 fl.dr. 15.8 ml.	2.6 fl.dr. 9.5 ml.	1.7 fl.dr. 6.3 ml.	3.2 ml.	0.789 ml.	0.833 ml.
1-1,600	½ pt. 8 fl.oz.	¼ pt. 4 fl.oz.	2 fl.oz. 59.1 ml.	1.2 fl.oz. 35.5 ml.	6.4 fl.dr. 23.7 ml.	3.2 fl.dr. 11.8 ml.	1.9 fl.dr. 7.1 ml.	1.3 fl.dr. 4.7 ml.	2.4 ml.	0.591 ml.	0.625 ml.
1-2,000	.4 pt. 6.4 fl.oz.	3.2 fl.oz. 94.6 ml.	1.6 fl.oz. 47.3 ml.	7.7 fl.dr. 28.4 ml.	5.1 fl.dr. 18.9 ml.	2.6 fl.dr. 9.5 ml.	1.5 fl.dr. 5.7 ml.	1.0 fl.dr. 3.8 ml.	1.9 ml.	0.473 ml.	0.500 ml.

Quantity of Insecticide on Basis of Active Ingredient

In preparing sprays or dusts with certain insecticides, notably the finely ground rotenone-bearing roots, the dilution is based upon the percentage (by weight) of the active ingredient desired in the finished combination. The following formulas may be found useful in determining the correct quantity of insecticide to be used.

Water suspensions or solutions.--To determine the quantity of insecticide necessary for a given percentage of active ingredient in the diluted spray, multiply the number of gallons of water by 8.345 by the percentage of active ingredient desired in the spray, and divide by the percentage of active ingredient in the insecticide. If, when making up small quantities of spray, it is desirable to calculate the quantity of insecticide in grams, substitute 3,785.3 for 8.345.

Example: Fifty gallons of spray containing 0.025 percent of rotenone is desired. The powdered root to be used contains 3.9 percent of rotenone. The quantity of this powder to be used is

$$\frac{50 \times 8.345 \times 0.025}{3.9} = 2.7 \text{ pounds.}$$

To determine the percentage of active ingredient in a given quantity of diluted spray when the quantity of powder used and its active of ingredient content are known, multiply the number of pounds of powder by the percentage of active ingredient it contained and divide by the number of gallons of spray times 8.345.

Example: One pound of ground derris root containing 4.8 percent of rotenone was used to make 50 gallons of spray. The rotenone content of the spray was

$$\frac{1 \times 4.8}{50 \times 8.345} = 0.0115 \text{ percent.}$$

Dusts To determine the quantity of insecticide to be used in preparing a dust containing a given percentage of active ingredient, multiply the percentage of active ingredient desired by the number of pounds of dust to be made and divide by the percentage of active ingredient in the insecticide to be used.

Example: One hundred pounds of dust containing 0.50 percent of rotenone is to be prepared. The powdered root to be used contains 4.0 percent of rotenone. The quantity of the root necessary is

$$\frac{0.50 \times 100}{4.0} = 12.5 \text{ pounds.}$$

Sufficient diluent is then added to make 100 pounds.

To determine the percentage of active ingredient in a dust when the quantity of insecticide used, its percentage active ingredient, and the total weight of the prepared dust are known, multiply the number of pounds of insecticide used by the percentage of active ingredient it contains and divide by the number of pounds of dust prepared.

Example: Twenty pounds of ground cube root containing 4 percent of rotenone had been used in making up 100 pounds of dust. The rotenone content of the dust was

$$\frac{20 \times 4.0}{100} = 0.8 \text{ percent.}$$

Percentage of Active Ingredient When Insecticide Is Diluted by Parts

When the percentage of active ingredient (rotenone, etc.) in the insecticide is known, the dilution, in parts, necessary to give a stated percentage of the active ingredient in the spray is obtained as follows: Divide the percentage of active ingredient in the insecticide by the percentage desired in the diluted spray.

Example: A spray containing 0.05 percent of nicotine is desired. The insecticide contains 40 percent of nicotine.

$$\frac{40}{0.05} = 800$$

The dilution is therefore 1 part of the insecticide to 800 parts of water.

When the percentage of active ingredient in the insecticide and the dilution (by parts) that was used are known, the percentage of active ingredient in the dilute spray may be obtained as follows: Divide the percentage of active ingredient in the insecticide by the dilution used.

Example: An alcoholic extract of pyrethrum containing 2 percent of total pyrethrins was diluted 1 to 400. The percentage of pyrethrins in the diluted spray was

$$\frac{2}{400} = 0.005 \text{ percent.}$$

Equivalent Dilutions of Active Ingredient in Parts and Percentages

Dilutions of rotenone and pyrethrins are often given as 1-5,000, 1-10,000, etc. The equivalent percentages for a number of these dilutions are given below.

Parts	Percent	Parts	Percent
1-500	0.2	1-5,000	0.02
1-1,000	0.1	1-6,000	0.0167-
1-1,500	0.0667-	1-7,000	0.0143-
1-2,000	0.05	1-8,000	0.0125
1-2,500	0.04	1-9,000	0.0111+
1-3,000	0.0333+	1-10,000	0.01
1-4,000	0.025	1-20,000	0.005

CONVERSION OF SMALL-SCALE DOSAGES TO LARGE-SCALE QUANTITIES

Dusts and Soil Insecticides

The quantities of dust or soil insecticides necessary for large-scale application, in pounds per acre, may be calculated from the quantities used in small-scale tests as follows: Multiply the number of grams or ounces per square foot by 43,560, or per square yard by 4,840, and divide by 453.59 if the dosage is in grams, and by 16 if it is in ounces.

Example: A dust has been found effective in small-scale tests when used at the rate of 0.30 gram per square foot. The equivalent dosage per acre would be

$$\frac{0.30 \times 43,560}{453.59} = 29 \text{ pounds.}$$

To determine the number of square feet (or square yards) that 1 pound of a given material will cover when the small-scale dosage per square foot (or square yard) is known, divide 453.59 by this dosage if it is in grams, and 16 by this dosage if it is in ounces.

Example: In the case of the 0.30 gram per square foot dosage mentioned above, 1 pound of the material would cover

$$\frac{453.59}{0.30} \text{ or } 1,512 \text{ square feet.}$$

To determine the quantity of material to be used for 1 square foot when the large-scale dosage is known, multiply the number of pounds per acre by 453.59 to obtain dosages in grams, and by 16 to obtain dosages in ounces, and divide the product by 43,560. For dosages per square yard the divisor is 4,840.

Examples: A dosage equivalent to 30 pounds per acre of a given dust is to be tried on a small scale. The dosage per square foot is

$$\frac{30 \times 453.59}{43,560} = 0.31 \text{ gram.}$$

$$\text{or } \frac{30 \times 16}{43,560} = 0.011 \text{ ounce.}$$

Some of these values that have been worked out and may be convenient for reference are given in the following table:

Equivalent small- and large-scale dosages

Dosage per square foot	Square feet that 1 pound will cover	Pounds per acre
Gram		
0.1	4,536	9.6
.10413	4,356	10.0
.15619	2,904	15.0
.25	1,814	24.0
.26032	1,742	25.0
Ounce		
0.005	3,200	13.61+
.008	2,000	21.78
.01	1,600	27.22+
.016	1,000	43.56
.025	640	68.06+
.064	250	174.24
.16	100	435.6

FUMIGANTS

The dosages of fumigants used in laboratory tests are readily converted to quantities to be used in large-scale work by the following relationship: Milligrams per cubic decimeter (liter) is approximately equal to ounces per 1,000 cubic feet.

The concentration of a given fumigant in the gaseous state within the fumigation chamber, generally determined by aspiration, is usually calculated in milligrams per cubic decimeter, and therefore, the same relationship would apply.

A series of tables, and formulas to use in connection with them, on the maximum weights of a number of common fumigants that can exist in vapor form in a 1,000 cubic foot fumigation chamber has been published by Roark and Nelson(5).

MISCELLANEOUS

Capacity of Sprayer Tanks

The capacity of the tanks of hand or power sprayers, in gallons, be calculated by 0.0034 as follows:

Cylindrical tanks: Multiply length by square of the diameter, in inches, by 0.0034.

Rectangular tanks: Multiply length by width by depth, in inches, by 0.004329.

Tanks with elliptical cross section: Multiply length by short diameter by long diameter, in inches, by 0.0034.

Dilutions of Alcohol and Other Liquids

From the commercial grain alcohol of 95 or any other known percentage, solutions of lower percentage can be prepared as follows: Into a 100-ml. graduate pour as many milliliters of the stronger solution as the percentage required in the weaker. Then add water until the mixture reaches the milliliter mark equivalent to the percentage of the stronger solution.

For example, to make 70-percent from 95-percent alcohol, pour into the graduate 70 ml. of the 95-percent solution and fill to the 95-ml. mark with water. The result is 95 ml. of a 70-percent solution.

The same procedure can be used for any other liquid, such as acetone, that is miscible with water, and in fact for any pair of miscible liquids.

The percentages obtained by this procedure must be expressed in terms of volume, not weight.

Temperature Conversion

Degrees Fahrenheit to degrees Centigrade: °C. = °F. - 32 X 5/9.

Degrees Centigrade to degrees Fahrenheit: °F. = °C. X 9/5 + 32.

A number of equivalents of the two scales are presented below:

°F.	°C.	°F.	°C.
0	-17.78	110	43.33
10	-12.22	120	48.89
14	-10	122	50
20	- 6.67	130	54.44
30	- 1.11	140	60
32	0	150	65.56
40	4.44	158	70
50	10	160	71.11
60	15.56	170	76.67
68	20	176	80
70	21.11	180	82.22
80	26.67	190	87.78
86	30	194	90
90	32.22	200	93.33
100	37.78	210	98.89
104	40	212	100

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